

A Introduction

Eco-driving is a fuel-efficient, adaptive and safe way of driving. Training in eco-driving teaches car drivers to utilise vehicles differently and bring out new potentials by adaptive driving including foreseeing traffic situations and economic ways of using gears and brakes. Drivers that receive eco-driving training reduce their fuel consumption.

Eco-driving requires no investment in equipment, since practically all new cars include technology that permits eco-driving. Training in eco-driving in Sweden consists of a theoretical part and a practical part. The effect of eco-driving can be calculated with electronic equipment registering fuel consumption, speed and driving time before and after the training as well as by having drivers keep a log book of driving distances and fuel consumption before and after training.

This measure concerns training municipal employees in eco-driving. Training only small numbers of employees in a large municipality like Malmö will lead to changes only on the part of those employees that have taken the training. By increasing the number of employees that have or will have had eco-driving training from the tens or hundreds to at least one thousand by the end of SMILE it is envisaged that a threshold will be reached whereby interest in eco-driving will begin to diffuse within the entire population of municipal employees and then beyond to the general populace in the city of Malmö.

Previous studies show that the positive effects of eco-driving wear off during the week and months that follow the completion of the training exercise. Drivers tend to fall back into previous habits meaning that vehicle fuel efficiency worsens and drivers are less adaptive in their behaviour and less economical in their use of gears and brakes. For optimal effect, initial eco-driving training should be complemented by periodic refresher sessions.

This measure concerns changing driver behaviour and thus the environmental performance of the municipal car fleet. This results in reduced fuel consumption and reduced emissions. However, in parallel with this measure are activities in SMILE measure 5.1 which are leading to a change in the composition of the municipal light vehicle fleet where the number of non-petrol powered vehicles has been increased considerably. This means that the overall environmental performance of the municipal fleet has the potential to improve via “behavioural change” i.e. measure 11.2 and via “technical equipment” i.e. measure 5.1.

A1 Objectives

The measure objectives are:

- **Objective 1** To give approximately 1500 municipal employees training in eco driving
- **Objective 2** Significant reduction of fuel consumption.
- **Objective 3** Reduction of emissions
- **Objective 4** Increased awareness
- **Objective 5** Increased acceptance

Evaluator's comments: Objectives 2-5 as expressed above are not quantified. Therefore while the measure can be evaluated, significant parts of the objectives cannot be assessed in the manner assumed possible in the table in C3 without applying the assumption quoted elsewhere in the measure documentation that ecodriving is expected to deliver a 10-15% reduction in fuel consumption at the level of the individual driver. It is not clear whose awareness and acceptance was originally envisaged to be measured in objectives 4 and 5.

A2 Description

Eco-driving is often considered a cost-effective and effective way of reducing fuel consumption - often on the order of 10-15% - by drivers learning a more efficient, adaptive and safe way of driving. Eco-driving requires no investment in equipment, since practically all new cars include technology that allows for eco-driving. Eco-driving teaches car drivers to utilise this built-in potential by

- adaptive driving foreseeing traffic situations
- economic ways of using gears and brakes

Prior to CIVITAS II, eco-driving was attempted in pilot studies in a number of Swedish cities including Malmö to decrease the fuel consumption and to teach car users a more efficient and safe way of driving. However, without training large numbers of municipal employees – and thus creating more interest among the majority of employees and without offering refresher courses, the benefits of eco-driving tend to be limited in time and scope.

Within this measure a large-scale demonstration of eco-driving has been carried out. As of October 2008 1091 City of Malmö employees have been trained in eco-driving which is considered to be a critical mass of drivers leading to some form of self-promotion. Information and experiences from this measure have been passed on to companies and the public through measure 11.1 – “Managing mobility needs of private persons and business sector”.

B Measure implementation

B1 Innovative aspects

New conceptual approach, locally - Reducing fuel consumption by eco-driving in this large scale has not been tested before in Sweden. It is hoped that the most considerable environmental effects will be in the private car use of the “newly trained” persons.

B2 Situation before CIVITAS

Prior to the start of SMILE few municipal employees had heard of eco-driving and even fewer had participated in eco-driving training. Fuel use on the part of the municipal fleet during 2004 is not known exactly but can be approximately estimated as shown in Table 2 in C1.2. The entire distance driven by the fleet was approximately 9 780 000 km based on a total of 489 cars as of 31 December 2004 each driven an estimated 20 000 km/yr.

B3 Actual implementation of the measure

The measure was implemented in the following stages:

Stage 1: Measure delay (*February 2005 – Spring 2006*) – During this period rapid succession of measure leaders meant that in practice the measure was not actively pursued or executed.

Stage 2: Measure implementation (*Spring 2006 – Autumn 2008*) – During the period there were two successive measure leaders who worked actively with this measure. Measure implementation consisted of several parts:

- A. Contacts with driver education schools to arrange for the provision of eco-driving training.
- B. Contacts with the municipal organisations to promote the idea of eco-driving and market the course opportunities
- C. Installation, in collaboration with individuals active with measure 11.1M, of measure equipment in 6 vehicles to gauge the effects of eco-driving training
- D. Eco-driving training held at several periods of time
- E. Some parts of municipal administration, for example at the Department for Environment Protection and the Department of Streets and Parks, made strategic decisions that all – or at least as many as possible – employees should partake in the training.
- F. Marketing of “the results” internally and externally.

Because of the decentralised nature of the municipal organisation, actual marketing *appears* to have taken place as a combination of active efforts on the part of the measure leader(s), more passive responses on the parts of some municipal organisations where employees could take the course if interested, more active responses where employees were more actively encouraged, and some diffuse informal word-of-mouth marketing. This makes it difficult to pinpoint the exact nature of the implementation at any given time since some of the initiative for the internal diffusion of the measure was, at times, taken up by interested individuals in their respective offices and departments.

B4 Deviations from the original plan

The deviations from the original plan comprised:

- **Deviation 1 Reduction in the numbers of participants** – The number of municipal employees partaking in the training has changed more than once during SMILE. Because of a miscalculation in the budgetary and planning process at the start of SMILE the number of participants in the measure was reduced to 2500 employees. According to the present (2008) measure leader this was subsequently reduced still further to 1500 because of difficulties in getting employees to participate. An analysis of the reasons for this change follows later in this report. According to an email from the present measure leader it has been suggested that the goal may have been reduced still further to only 1000 employees.
- **Deviation 2 Lack of formal plan and implementation methodology** – It would appear from the Detailed Measure Plan (DMP) and from discussions with the initial, temporary measure leaders during 2005 as well as the first actual measure leader during 2006 that there was no formal plan and implementation methodology in place to execute this measure. It would seem that at that time there was uncertainty as to how the marketing of the measure should proceed and whether individual city departments or offices should be focused upon -- one after the other, according to a yearly plan -- or whether all departments should be reached in a more general fashion from a central marketing function. Given the decentralized nature of the city administration it might have also been possible to appoint “active ambassadors” in the various departments to help with marketing on site. At some point, probably towards the end of 2006, a plan and marketing strategy crystallised.

While Deviation 2 is not a deviation from the original plan *per se*, in a sense the lack of clear strategy and implementation methodology appears to deviate from many other SMILE measures in Malmö where implementation in practice was planned prior to the start of SMILE and if measure leaders discovered flaws or shortcomings in delivery methodology etc they took steps to improve the original planning. Perhaps the central problem is that the original measure leader -- or at least the person envisaged as the measure leader prior to the actual start of SMILE -- did not pass on his/her implementation plan/strategy to one or more of the numerous measure leaders during the first year of SMILE or, apparently, the Site Manager at the time.

B5 Inter-relationships with other measures

The measure is related to other measures as follows:

Measure 5.1 (Clean Municipal Vehicles) – in that both measures are aimed at reducing energy use and emissions resulting from the use of the City of Malmö’s in-house vehicle fleet.

Relations among the eco-driving measures in SMILE Malmö:

In Malmö there are four measures – 5.3, 11.2, 11.8, 11.9 -- that deal solely or in part with what is called “eco-driving” which is a driver technique, approach and strategy to reduce fuel consumption without reducing driving speed. While all four measures include eco-driving, the results are not always easily compared and some of the assumptions or factors used in calculations differ between these measures. The reasons for this are as follows:

The target staff or drivers have varying degrees of incentive or motivation to continue to apply the eco-driving technique in the weeks, months and years following their training. The primary incentive comes from a reward, often in the form of financial gains – directly or indirectly – corresponding to the costs of saved fuel that has resulted from eco-driving.

The target staff or drivers have different relations to the vehicles and their work situation. Some of the drivers in some of the measures are professional drivers: that means driving is their occupation. Such drivers may have regular routes that they take where they may be able to perfect their efforts to reduce fuel. Others driver vehicles rather regularly as part of their work, but this is not the primary part of their occupation or profession. Still other driver may irregularly and for shorter distances use vehicles as part of their work. This means that the results of the eco-driving measure will vary because of the frequency of driving and at the relative centrality of driving as part of the employees’ occupation.

Some drivers almost always drive the same vehicle. Infrequent drivers are more likely to drive a different make of vehicle almost every time they need to used a vehicles.

Finally, there are different kinds of vehicles that are used by drivers in the four measures and the reasons for driving vary.

In comparison we can say:

5.3

That the drivers of heavy vehicles in 5.3 are employees of freight haulers and these employees may not be receiving a financial incentive. The supplier of the training, Skånemejerier, is not the employer. There are indications that the effects of eco-driving fell from about 13% to about 3% reduced fuel use when there was no refresher training but this may have then improved when refresher training was introduced much later in the measure.

11.2

For the municipal employees in 11.2 the initial reduction of fuel was about 13% but since the employees have no incentive to continue to drive this way (fuel savings do not accrue to them, they are not awarded in some other way), this savings tends to have approached nil within a year and we assume that it is zero after one year. There is no refresher training. Most managers or section heads do not see the relation between training staff in eco-driving and financial performance of their section.

There are some exceptions within 11.2 among individual drivers and managers who can see the benefit from eco-driving for their section's financial performance but these are truly the exception.

11.8

In the hospital, it proved difficult initially to get any medical or care staff to take the training. As a result we only have statistics from the regular transportation staff in the hospital. There may be some measure of incentive for the transportation staff since it is a small unit and cost savings can be more easily tracked and attributed to driver performance. For the other parts of the hospital where staff took the training fuel costs are often small in comparison with the total budget and it is hard for either the managers or staff to see the advantage: again there is no incentive.

11.9

This last measure like 5.3 only involves heavy vehicles. However, unlike 5.3, most people who took the training were owner-operators of their own vehicles and as such have a financial incentive to maintain a high degree of eco-driving performance. From an initial savings of about 17% in terms of fuel consumption this falls to 10% or less in the longer-term. However, fuel savings accrue to the individual driver or, in some cases, the small firms that have joined the umbrella organisation Malmö LBC.

Thus we see that even if all measures attempt to reduce fuel consumption use the same basic techniques and methods, the context within which the measure is rolled-out has a clear impact on the long-term effects. More motivated drivers with a form of incentive tend to have driving habits similar to the ideal in eco-driving than drivers who have no form of incentive at all. Motivated drivers retain the positive effects of eco-driving.

This lengthy passage appears verbatim in the B5 section of 5.3, 11.2, 11.8, 11.9 to make it easier for readers who might want to compare these measures.

C Evaluation – methodology and results

C1 Measurement methodology

C1.0 General methodological discussion

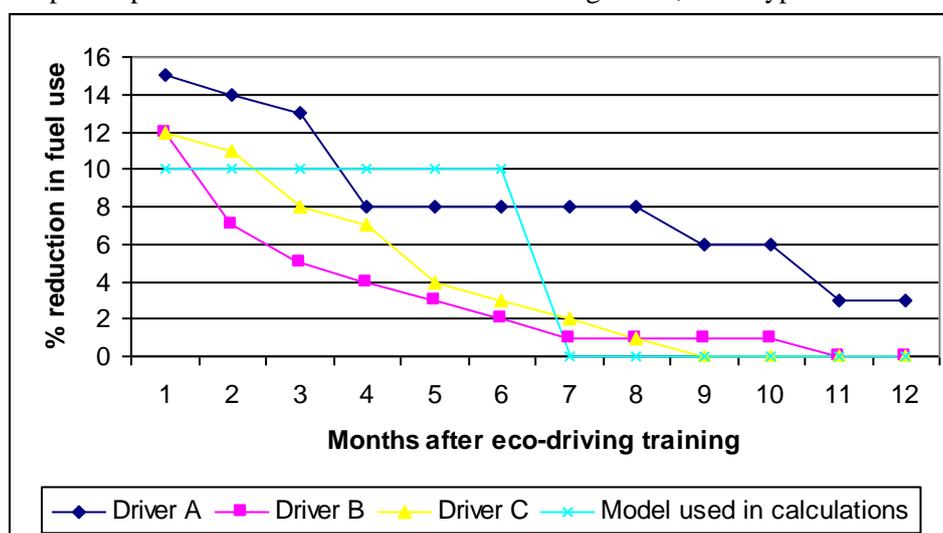
The reduction of fuel use and hence reduction of emissions is unknown. Instead based on certain assumptions, reduced fuel usage and emissions is estimated or derived.

Discussion and assumptions made:

1. Eco-driving training leads to immediate reductions in fuel use on the order of 10-15% per person in the days immediately following the training session. This is consistent with similar projects carried out with municipal employees in other places or other times in Sweden.
2. The immediate effect from eco-driving, while highly variable, tends to be approximately 10%.
3. The positive effects of eco-driving diminish after the training if no regular programme of refresher or brush-up training is provided. Researchers and experts in this area agree on this.
4. The degree to which the positive effects of eco-driving are retained by participants has been misjudged in the planning for this measure. On the other hand there is little concrete evidence to work with.
5. The degree of and rate of diminishing effects from point 3 above is not known and researchers and experts in Sweden believe that there are no studies which conclusively have been able to document the average rate and degree of reduced effects when eco-driving is conducted in projects similar to SMILE measure 11.2..

6. For this evaluation, we will assume that the effect is completely gone for the average driver one year after the training is taken. In actual practice, the degree and rate of reduction varies considerably by individual. In all likelihood the figure of one year is probably too optimistic given that eco-driving demands more attention on the part of drivers and a typical driver may often prefer to take a more 'relaxed' approach to driving, ie rapidly fall back into old habits.
7. No refresher training has been held. Obviously a few municipal employees may have taken eco-driving prior to SMILE, a few employees may have been able to participate in more than one training session; and a few employees may have experienced eco-driving training outside their employment in the municipality. However we will assume that no employees have had refresher courses.
8. Based on these assumptions, we will assume that the effects of eco-driving are the equivalent to a 10% reduction in fuel use for 6 months (see "Model used in calculations in Figure 1 below) directly after training and a return to pre-training consumption levels for the remainder of SMILE.

Figure 1: Graphic representation of reduction of eco-driving effect, three typical drivers and a model



In figure 1 we see three hypothetical drivers and the reduction of fuel consumption when they drive during the year following their eco-driving training. Driver A starts out with a 13-15% reduction in fuel use immediately after training, then appears to settle on a rather high level of reduced fuel use, then after almost half a year reverts slowly to old habits but uses less fuel even at the end of one year. Driver B forgets the lessons of eco-driving very quickly and after about half a year the effects are largely absent. Driver C also forgets the lessons of eco-driving but initially tends to do rather well. However after about half a year Driver C has fallen to a level similar to that held by Driver B. The model used in calculations is that all drivers have a 10% reduction during six months after which time the effects of eco-driving training disappear completely.

9. Assumptions concerning driving habits and distribution of driven km by municipal employees: In Malmö there are 19 400 employees. It is assumed that 25-30% of the employees never or almost never drive one of the cars in municipal fleet because of the nature of the employees' work or that the employee lacks a driving licence. It is further assumed that 20% of the employees drive municipal cars long distances on a daily basis. Such employees might work in care for the elderly or in technical service occupations or park or building maintenance. Finally it is assumed that the remaining employees, 50-55%, drive municipal cars on a somewhat regular basis but only for short distance. The general idea is that over half of all km driven per year are the results of some 4000 employees' trips and the remaining km result from the majority of employees, (10000), who use the vehicles much less frequently.

10. The most important assumption from 9 is that approximately 1/4 employees essentially never drive municipal vehicles. This means that these employees are effectively removed from further consideration in this measure: they cannot or should not take eco-driving training in a programme for employees. Therefore, for this measure, there are only about 14 000 employees who could potentially take eco-driving training.
11. With 1091 employees having taken or scheduled to take eco-driving as of late October 2008, we will assume that 1120 employees took training during SMILE and that this represents 8% of the total distance driven by employees during 2008.

C1.1 Impacts and Indicators

Table 1: List and description of data collection indicators used in the technical evaluation of this measure.

Nr.	INDICATOR Name	Possible DESCRIPTION	DATA /UNITS
3	Vehicle fuel efficiency	Fuel used per vkm, per vehicle type	MJ/vkm (or similar), derived
13	Awareness level	Degree to which the general public awareness has changed	Survey
14	Acceptance level	Survey of opinions on part of general public	Survey
8, 10, 11	"Reduction of emissions"	Emissions of CO ₂ , NO _x and PM ₁₀ .	Kg or g/vkm, derived

Detailed description of the indicator methodologies:

- **Indicator 3** (*Vehicle fuel efficiency*) – This is the estimated effect of eco-driving on the consumption of fuel. Consideration of the changes in the municipal fleet as part of SMILE measure 5.1 is dealt with in the analysis and data.
- **Indicator 13** (*Awareness level*) – Awareness on the part of the general public in Malmö concerning eco-driving and that the municipality has sought to train all of its employees (or at least many of them, depending on which version of the contract is to be referred to) in eco-driving.
- **Indicator 14** (*Acceptance level*) – Acceptance on the part of the general public in Malmö concerning eco-driving and that the municipality has sought to train all of its employees (or at least many of them, depending on which version of the contract is to be referred to) in eco-driving.

Objective 3 from section A1 is "Reduction of emissions" but there are no quantified numbers associated with this goal for assessment purposes. Nevertheless numbers have been derived for CO₂, NO_x and PM₁₀ emissions and are presented under C1.2, C1.3 and C2.3. This data is based on the assumed reduction of fuel use (indicator 3) when multiplied by generic emission factors data.

For further explanation why indicators 2 and 3 covered the general public and not the municipal employees see problems identified in C5.

C1.2 Establishing a baseline

The baseline is the situation during 2004 just prior to the start of SMILE. At this time the overwhelming majority of all employees in the City of Malmö had never received any eco-driving training but awareness of the concept may have been present in parts of the administration.

During 2004 we can assume that the entire municipal fleet of light vehicles was driven 9 780 000 km/year based on information received from the city that their cars were driven an average of 20 000 km/year and that on 31 December 2004 the city owned or leased 489 cars or similar light vehicles.

Since the fleet of light cars did not run solely on petrol at this time and approximately 33% of all vehicles were “environmental” or “clean” cars running on other fuels, consumption of fuels will be stated in a table based on the types of cars. Approximately 16% of the fleet were powered primarily with E85, approximately 16% of the fleet were powered primarily with natural gas and approximately 67% of the fleet used petrol. The remainder (less than 1%) used electricity or were electrical/petrol hybrids.

The relationship between on the one hand those employees that in the future would take eco-driving and on the other hand the kinds of vehicles that they drove in 2004 versus later in SMILE is complex. Furthermore, the size of the fleet grew during SMILE. The complexity of the relationship between employee trained in eco-driving and which cars he/she uses can be demonstrated as follows:

- Employee A takes eco-driving during 2006 and mostly drives petrol vehicles during 2006 and 2007. By 2008 “A” is usually driving an E85 vehicle because of the large number of such vehicles procured during 2008 by the department A works in. However, the effects of eco-driving have worn off.
- Employee B takes eco-driving training during 2008. “B” drove mostly E85 and Gas vehicles during 2006 and 2007 because the department B was in had been working hard to replace vehicles as part of 5.1. However at the end of 2007 “B” switches workplaces and the new department has mostly conventional petrol vehicles. Thus “B” no longer drives E85 and Gas vehicles at work.
- Clearly other relationships are also possible.

Therefore this evaluation must use the entire fleet in aggregate as a baseline.

Fuel consumption by and emissions from the vehicles were as follows:

Table 2: Fuel consumption by the municipal fleet just prior to start of SMILE calculated as one year

E85 vehicles	Gas vehicles	El/hybrid	Conventional petrol	Total fuel usage
131719 litres E85 45438 litres petrol	76636 N m ³ gas 45438 litres petrol	2813 litres petrol	571242 litres petrol	664931 litres petrol, 131719 litres E85, 76636N m ³ gas
Assumption E85 67% and petrol 33% usage, E85 consumed 0.124 litres/km	Assumption natural gas used 67% and petrol 33%	Assumed to be 50% of conventional petrol	Assuming 0.087 litres/km	Total energy: 6051500 kwh petrol 840246 kwh E85 840246 kWh gas

Conversion factors used for total energy usage:

E85 6380 kwh/m³, [Natural] gas ~11000 kwh/N m³ gas, Petrol 9100 kwh/m³, Diesel 9800 kwh/m³, Fuel gas [50% natural gas, 50% biogas] ~9700 kwh/N m³ gas

From table 2 we get 7731992 kWh total energy or 2147775 MJ. The total distance driven by the fleet was 9 780 000 km during 2004 which leads to energy use per vkm of 0.219 MJ/km.

Table 3: Emissions from the Malmö City fleet end 2004/start 2005 on a yearly basis.

	E85	Gas	Electric/ elec hybrid	Conventional petrol	Total
CO ₂	139700 kg	260740 kg	62010 kg	124750 kg	1654190 kg OR ~1654 metric tons
NO _x	60610 g	60610 g	1810 g	361130 g	484170 g OR ~484 kg
PM10	6340 g	4220 g	130 g	26260 g	36950 g OR ~37 kg

From table 3 the total emissions are divided by the total distance driven by the fleet which leads to 0.169 kg CO₂/vkm, 0.049 g NO_x/vkm and 0.0037 g PM10/vkm.

This baseline is identical to the baseline established for 5.1 minus the discussion about awareness and acceptance contained in 5.1. For more detailed understanding how this baseline was calculated please refer to section C1.2 in the measure template for 5.1.

C1.3 Building the business-as-usual scenario

Since measure 5.1 involved changing the composition of the fleet vehicles, and the evaluation of 5.1 was conducted in such a way that 11.2 and its effects were kept separate from 5.1, this means that the results of SMILE measure 5.1 - as reported in the 5.1 template - becomes the business-as-usual scenario for 11.2. This is because the business-as-usual scenario for 11.2 is to not train employees in eco-driving yet all other things remain unchanged.

The business-as-usual scenario for 11.2 follows in tables 4 and 5 below with fuel consumption and emissions. This scenario is based on the vehicles in use and their fuel consumption during SMILE month 43 multiplied by 12 months to generate a fictive year “2008” as the present situation.

Since the fleet now contains more vehicles and the total distance driven by the vehicles has increased from 9 780 000 km/year to 12 660 000 km/year this means that, while fuel consumption and emissions in total may have increased, in relation to vkm/year driven by the fleet consumption and emissions have fallen.

Table 4: Fuel consumption by the municipal fleet during SMILE month 43

E85	Gas	Electric/ Electric Petrol Hybrid	Diesel	Efficient petrol	Conventional petrol	Total fuel usage
302411 litres E85 104504 litres petrol	193723 N m ³ gas 105078 litres petrol	21120 litres petrol	24840 litres diesel	4000 litres petrol	384540 litres petrol	619243 litres petrol, 302411 litres E85, 193723 N m ³ gas, 24840 litres diesel
Based on assumption E85 67% and petrol 33% usage and that E85 is consumed 0.124 litres/km	Based on the assumption that fuel gas used 67% and petrol 33% AND that fuel gas is 50% CNG/50% biogas	Assumed to be 50% of conventional petrol	Assumption 0,069 litres/km	Assumed to be 50% of conventional petrol	Assuming 0.087 litres/km	Total energy: 5573187kWh petrol, 1929382 kWh E85, 1879113 kWh fuel gas, 243432 kWh diesel

Conversion factors used for total energy usage:

E85 6380 kwh/m³, [Natural] gas ~11000 kwh/N m³ gas, Petrol ~9000 kwh/m³, Diesel 9800 kwh/m³, Fuel gas [50% natural gas, 50% biogas] ~9700 kwh/N m³ gas. Petrol figure for 2008 lower than 2004 because of “petrol” now *always* containing 5% ethanol.

From table 4 we get 9625114 kWh total energy or 2673643 MJ. The total distance driven by the fleet was 12 660 000 km in the business as usual scenario for “2008” which leads to energy use per vkm of 0.211 MJ/km.

Table 5: Emissions from the Malmö City fleet for SMILE month 43 used as the business as usual scenario for 2008.

	E85	Gas	Hybrid	Diesel	Efficient petrol	Conventional petrol	Total
CO ₂	316097 kg	735660 kg	46080 kg	63720 kg	8720 kg	822120 kg	1992398 kg or 1992 Tonnes
NO _x	96824 g	147132 g	13440 g	68400 g	3200 g	176800 g	505796 g or 505,8 kg
PM10	14560 g	14713 g	960 g	5760 g	320 g	17680 g	53993 g or 54 kg

From table 5 the total emissions are divided by the total distance driven by the fleet which leads to 0.157 kg CO₂/vkm, 0.040 g NO_x/vkm and 0.0042 g PM10/vkm. This suggests that the business as usual scenario, in comparison with the baseline, has led to reductions in CO₂/vkm and NO_x/vkm but increases in PM10/vkm.

C2 Measure results

The results of this measure can be considered to be the difference between the business-as-usual-scenario and the effects of the eco-driving. It would be inappropriate and methodologically incorrect to see the results as the difference between the effects of the eco-driving and the baseline. This is because of the increase in the number of vehicles and the corresponding increase of the total distance the fleet was driven together with the increasing percentage of clean cars in the fleet.

Awareness and acceptance was not clearly defined in the measure. Here we use the awareness and acceptance on the part of the general public. It might have been of interest to have polled awareness and acceptance on the part of municipal employees and particularly those employees that took the eco-driving training but this was not included as part of the initial evaluation planning. Furthermore, given the difficulties to get driver journals out to the right employees at the right times and returned and completed in a timely fashion it is highly likely that polling employees about awareness and acceptance would have led to similar meagre levels of data collection.

The results are presented under sub headings corresponding to the areas used for indicators – economy, energy, environment, society and transport.

C2.1 Economy

Since the original measure description did not have goals concerning economic results, indicators for this measure were not deemed necessary in the initial local evaluation plan. Subsequent developments within SMILE and GUARD's own internal interests showed that all measures would be required to provide revenues and expenses for each measure.

Revenues: This measure has no revenue if revenue is taken to mean income generated by the measure.

The expenses for this measure are related to the personnel costs for the measure leader and various marketing or information materials etc as well as the sub-contracting costs for when enlisting private driver education companies that trained municipal employees. Possible reduced expenses for fuelling vehicles are not included in this part of the report since the latter changes are defined as not being part of the measure *per se* but rather an indirect result of the measure.

Costs: Seen in this light the costs for this measure total approximately € 300 000 during the duration of SMILE based on the table below.

Table 6: Approximate cost breakdown for the SMILE measure 5.1, vehicles until SMILE month 43, other cost categories until SMILE month 48.

Type of cost	Total sub-contracting cost*	Salary of measure leader**	Other costs
Cost	€ 245 000	€ 53 000	€ 2 000

This equates to a cost per person trained of €200.

* Notes and explanation concerning the cost breakdown.

1. This is the total cost for sub-contracting to the private driver education schools based on the budget for the entire SMILE period.
2. The figure for salary comes from the budget for the entire SMILE period.
3. Finally, there were other costs for this measure that appear to have been borne by either 11.1 or some other source of funding. People involved in 11.1 assisted in some capacity in the internal marketing process. 6 fuel consumption measurement units were purchased and installed in vehicles in an attempt to measure reduced fuel consumption. While these costs are not known to the evaluator and some, apparently, have been taken from other sources of funding, here a figure of € 2 000 is included as an additional cost borne by the SMILE measure.

C2.2 Energy

The following amounts of fuel have been estimated to have been saved / will have been saved during the duration of SMILE.

Summary of assumptions made on pages 5-6: approximately 8% of all drivers that could take eco-driving training will have done so by the end of SMILE, the effects of their training are a 10% reduction of fuel consumption during the first six months following training and thereafter this falls to 0% reduction. However in the results below a range of results are presented corresponding to a 10% reduction during 6 months and a 10% reduction during 12 months.

Further assumptions: that the 1120 trained employees received their eco-driving training at these times: 350 during 2006, 370 during 2007, 400 during 2008 and January 2009. However, for simplicity all training is accounted for as occurring during 2008 with corresponding reductions all placed during that year (in keeping with the comparison with the business as usual methodology!).

Recall that during the “2008” BAU scenario (SMILE month 43 used as the basis) 12660000 km were driven. 8% of all drivers, assuming that all drivers cover the same distance in one year, equals 1012800 km. Given that the range of the effects varies between 6 months to 12 months this means that between 1/3 and 1/6 of the total kilometres driven by the trained drivers’ in this period were subject to eco-driving. This means that of all driver km between ~2.7% and ~1.3% were covered by the effects of eco-driving training. This means that of the entire 12660000 km driven, between 341820 and 164580 km can be considered eco-driving km. This leads to a total savings in fuel usage (assuming that the km are distributed evenly among all types of cars and fuels) as follows (10% reduction for those km).

Table 7: Calculation of fuel usage in the comparison of the business-as-usual versus effects of SMILE measure 11.2 on an annual basis

Scenario/effect	Total fuel usage
Business as usual	619243 litres petrol, 302411 litres E85, 193723 N m ³ gas, 24840 litres diesel
2.7 to 1.3 % of the business as usual consumption: i.e. the % of consumption covered by eco-driving	16719 to 8051 litres petrol 8165 to 3931 litres E85 5230 to 2518 N m ³ gas 671 to 323 litres diesel
10% reduction of fuel used during driven km effected by eco-driving training	1672 to 805 litres petrol 817 to 393 litres E85 523 to 252 N m ³ gas 67 to 32 litres diesel

Table 8: The total fuel consumption as a result of this measure

	Business as usual	High end reduction estimate	Low end reduction estimate
Petrol	619243 litres petrol	1672 litres petrol	805 litres petrol
E85	302411 litres E85	8817 litres E85	393 litres E85
Gas	193723 N m ³ gas	423 N m ³ gas	252 N m ³ gas
Diesel	24840 litres diesel	67 N litres diesel	32 N litres diesel

This means a reduction in total fleet fuel consumption by 0.27-0.13% probably towards the lower end reduction estimate. If we assume a 0.2% reduction that would mean that the energy use per vkm fell from 0.211 MJ/vkm to 0.210 MJ/vkm.

C2.3 Environment

Given that energy use fell from the business-as-usual scenario of 0.211 MJ/vkm by only 0.001 MJ/vkm, this would suggest that reductions of pollutants to the air from the fleet should fall by a small amount as well, about 0.47%.

Table 9: Estimated reductions in air pollutant emissions as result of eco-driving

Pollutant	Estimated reduction during entire SMILE (3 years)
CO ₂	9364 kg
NO _x	2377 g
PM10	254 g

C2.4 Transport

There are no indicators associated with this measure in the area of “transport” since there are no objectives in this particular area.

C2.5 Society

Awareness and acceptance of the measure on the part of the general public are the two indicators used and reported upon here. Awareness and acceptance on the part of municipal employees might have been an alternative indicator but as discussed in among other places C5 this has not been possible.

The general public survey undertaken as part of SMILE during April and May 2008 polled members of the general public in various public spaces about a number of matters concerning SMILE measures. The results of the survey suggest that perhaps as many as 2% of the general public are aware that Malmö is offering eco-driving training to many of the municipal employees in Malmö.

C3 Achievement of quantifiable targets

The reader is hereby reminded that Objectives 2-5 did not contain quantifiable targets.

No.	Target	Rating
1	To give approximately 1000-1500 municipal employees training in eco driving	**
2	Significant reduction of fuel consumption	A – No T
3	Reduction of emissions	A – No T
4	Increased awareness	0
5	Increased acceptance	0
NA = Not Assessed 0 = Not achieved * = Substantially achieved (> 50%) ** = Achieved in full *** = Exceeded A – No T = Assessed but no target to compare with		

Table notes:

1. The assessment of success depends on which of the different targets we choose to compare against. Assuming that target of 2500 municipal employees was unrealistic then using a range of the later values 1000-1500 means that we can say that the target has been achieved.
2. Since the term “significant” is not defined and there appears to be no guidance in the documentation as to what is meant by the term there is no quantifiable target with which to benchmark against. The estimated reduction appears in table 8. What is “significant” is left up to the reader, but the author of this report would like to suggest that because the positive effects of eco-driving can wear off quickly unless reinforced by refresher training or backed up by a monitoring and incentive programme that the reduction in actual practice has not been significant.
3. Reduction of emissions: Here, again, there is no numerical value associated with changes in emissions. Instead the estimated reduction in emissions appears in table 9.
4. Increased awareness has been assessed in a public survey but there are no quantifiable targets to relate to. Instead data is presented in section C2.4
5. Increased awareness has been assessed in a public survey but there are no quantifiable targets to relate to. Instead data is presented in section C2.4

C4 Up-scaling of results

The following suggestions are possible:

1. Make sure that all employees take eco-driving training, or at least target the regular drivers of municipal vehicles. However, in this measure the objective of the number of trained employees has been ratcheted downwards, suggesting that this may prove problematic.
2. Make a provision for employees to take refresher training sessions, at least once every second year and preferably more often.
3. Create a position in the city administration for internal drivers education so that this staff member trains employees, markets these services and, during periods of peak demand, enlists the services of private driver education schools.
4. Coordinate eco-driving efforts with other large organisations in Malmö, for example some of those participating in SMILE to show to participants that eco-driving is part of a city-wide effort.
5. A combination of one or more of these suggestions.

Assessment of these suggestions:

1. While in principle many upper and middle-level managers may be positive towards eco-driving, when it comes to granting employees time to take a half-day training session problems appear to arise. In some parts of the city administration with regularly scheduled employee tasks and constraints to take on additional temporary staff (both financial and human resource limitations), training sessions of this kind often appear difficult to

arrange. Training and continuing education for tasks considered directly related to employee responsibilities may often be easier to arrange, for example for regular drivers of municipal vehicles. Perhaps eco-driving training should be repackaged into a broader competence training session that would bring down participation barriers. This would require linking in eco-driving sessions into other planned sessions of training and continuing education based on the more exact needs of specific municipal departments and offices.

2. For this to be realised point one will have to be successfully resolved. There is little point to work for refresher courses on a broad scale as long as initial participation remains at levels much lower than original hopes and expectations.
3. This is a cost and organisational question. Perhaps this position could be placed at VISAB, the municipally-owned company that buys and then “internally” leases vehicles for municipal office and department use?
4. This suggestion has arisen in discussions with previous measure-leaders as well as with UMAS (hospital) whose own eco-driving measure suffered from a delay in implementation.
5. The success and wisdom of a combined approach can be considered based on a further assessment of the practical feasibility of the four other suggestions.

Driver education schools, because of a national policy decision, have begun to integrate “eco-driving” concepts and methodology into the regular curriculum. This means that at some point in the distant future, when the majority of present municipal employees have retired or assumed other occupations, the need for and importance of training municipal employees in eco-driving will decline. However, prior to this the municipality should consider some sort of driver feedback and monitoring system in vehicles so that drivers – and their bosses -- might be made aware of their shortcomings and thus increase interest in and motivation for participation in eco-driving training. Such systems would also prove helpful in the evaluation of refresher sessions and make participation in such sessions more appealing.

In theory there is no reason except institutional desire why all municipal drivers could not be trained in ecodriving by 2015, but it is not clear that such a desire exists throughout the city authority.

C5 Appraisal of evaluation approach

The decentralised nature of the city administration combined with the measure leader (ML) turnover and an uncertainty about marketing and strategy on the part of the first measure leader who actually worked with the measure has made data collection difficult. During the initial period of 2005 and into 2006 when measure leaders were appointed on paper but not in practice the evaluator attempted to impress about the MLs the need to focus efforts on departments so that perhaps two departments could be chosen for close scrutiny in the evaluation process. This would have led to more data collection and better data quality. This discussion continued with the measure leader during 2006 but no headway was reached.

The result was that since measure leaders at times were uncertain when training was going to be actually conducted and EXACTLY which staff would attend, it became problematic to use driver journals to establish the changes of individuals driving habits prior to the eco-driving training, in a period immediately after the training, and at a later point in time when the effects of such training had worn thin. Sending out and receiving in return three sets of driver journals proved impossible to arrange given the complexities and decentralised nature of the city administration, the nature of the measure marketing and execution and the difficulties to attempt to establish direct contacts between the evaluator and people at the various municipalities who had some sort of local, coordinating role. Because of this the number of journals received in full proved too few to be meaningful and this method was largely abandoned before the start of 2007.

In hindsight, with essentially all of the employees at the Department of Streets and Parks and essentially all of the employees at the Department of Environmental Protection having now taken the eco-driving training at some point during SMILE, it would appear to be simple to have completed the initial evaluation methodology with a focus on the two departments. However, for this to have been possible would have required another execution framework for this measure, much more understanding about the needs of the evaluation and how this should have impacted on measure implementation by the measure leader who started during 2006 – i.e. to be able to see beyond merely getting employees to take the training – plus an understanding on the part of the then ML that facilitation of the evaluation would improve if the evaluator was willingly given direct access to possible contact persons in the various city offices so that the layers of communication could be reduced.

Because of these difficulties in combination, the measure has been assessed at an aggregate level which means that the evaluation rests on several assumptions and less on data collection. This has assumed that the ecodriving training has been spread across all drivers of municipal vehicles, both occasional and regular.

C6 Summary of evaluation results

The key results are as follows:

- **Key result 1** – Reduction of fuel use. This measure reduced fuel consumption (and resulting CO₂ emissions) by 0.01 MJ/vkm (0.47%) on average across the whole municipal fleet, at an individual level a short term reduction of 10% (i.e. 0.21 MJ/vkm) can be assumed, but tailing off as time passes.
- **Key result 2** – Reduction of emissions. This measure reduced emissions by approximately 0.47% across the whole municipal fleet, a very marginal improvement.
- **Key result 3** – This measure has not been as successful as had been hoped for because of difficulties in getting municipal employees to participate in the training. It is suspected that the principle reason for this difficulty is not that employees do not want to take eco-driving but is rather a management issue: middle-level managers find it difficult to find time for staff to participate.
- **Key result 4** – For this measure to be successful in the long-term, once the issue raised in result 3 is addressed it is imperative that the municipality finds ways to give repeater training and the resources/possibilities for staff to take such training.

D Lessons learned

D1 Barriers and drivers

D1.1 Barriers

- **Barrier 1** – Reduction in the numbers of participants occurred more than once during the project mainly because of a miscalculation in the budgetary and planning process at the start of SMILE and because of apparent lack of interest and difficulties to get employees to participate in the training programme.
- **Barrier 2** – In some parts of the city administration with regularly schedule employee tasks and constraints to take in additional temporary staff training sessions of this kind may appear difficult to realise.

- **Barrier 3** – Because of the decentralised nature of the municipal organisation it might be possible for marketing activities to lack a co-ordinated approach to reach all employees.
- **Barrier 4** – There were rapid succession of measure leaders at the start of the project which delayed implementation. Also, the original measure leader, or the person envisioned as the measure leader prior to the actual start of SMILE, did not pass on his/her implementation plan/strategy to one or more of the numerous measure leaders during the first year of SMILE.
- **Barrier 5** – Studies of non-SMILE projects in Sweden, similar to 11.2 have frequently failed to measure long-term results. The few Swedish studies of the effects of eco-driving in projects like 11.2 point to the strong tendency that the benefits of eco-driving diminish at some point, often weeks or months, after the training. This defies the purpose of Objective 2 and 3 of the measure and does not represent value for money.
- **Barrier 6** – To maintain the benefits of eco-driving it is suggested that refreshers courses or similar “reminders” are offered to participants which. Depending on the choice of frequency of such courses or reminders, and whether these can be bundled together with other occupational courses staff to improve their performance, such reminders may or may not prove costly both because of the financing of these courses but also because employees are absent from work during training sessions. See the discussion under recommendations for more on this matter.
- **Barriers 7.** – Municipal employees have no incentive to continue to drive according to the principles of eco-driving.

D1.2 Drivers

- **Driver 1** – Eco-driving is considered a cost-effective and effective way of reducing fuel consumption and emissions and improving the environmental performance of the municipal car fleet.
- **Driver 2** – Eco-driving requires no investment in equipment, since practically all new cars include technology that allows for eco-driving.
- **Driver 3** – It is estimated that there has been a reduction in fuel use and reduction of emissions, which is a positive message for marketing and promotion of this measure.

D2 Participation of stakeholders

- **Stakeholder 1** – Miljöförvaltningen (Environment Department), City of Malmö, has a leading role, setting up training schedule, contracting traffic school
- **Stakeholder 2** – Gatukontoret (Roads and Parks Department), City of Malmö, is a principal participant, designing communication strategy and information material
- **Stakeholder 3** – All municipal employees of the City of Malmö
- **Stakeholder 4** – The ecodriving trainers

D3 Recommendations

- **Recommendation 1** – Studies in Sweden show that the positive effects of eco-driving wear off during the weeks and months that follow the completion of the training exercise. To maintain the environmental benefits it is necessary that the initial eco-driving training is reinforced by one or more of the following, which can even be implemented in a combined

way: Periodic refresher sessions or other “reminder” programmes or a proper fuel management programme including:

- Monitoring at the level of individual drivers
 - Performance feedback
 - Incentives
 - Refresher training
- **Recommendation 2** – It is recommended that to achieve wider benefits of this measure the eco-driving is encouraged and promoted for personal use. Indeed, the original project description for 11.2 suggested that this would be an indirect benefit of this measure.
 - **Recommendation 3** – It is recommended to co-ordinate eco-driving efforts with other large organisations in Malmö to show to participants that eco-driving is part of a city-wide initiative.

D4 Future activities relating to the measure

The evaluator is not aware of any such activities to be conducted by the City of Malmö at this time. Driver education schools, because of a national policy decision, have begun to integrate “eco-driving” concepts and methodology into the regular curriculum that all people learning to drive a car must take. This latter development has not been the result of SMILE.